Survey of Wyoming Crayfishes: 2007-2009

Wayne A. Hubert, Leader

U.S. Geological Survey,

Wyoming Cooperative Fish and Wildlife Research Unit,

University of Wyoming, Laramie, Wyoming

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Abstract.--Crayfishes were collected from waters in Wyoming by Wyoming Game and Fish Department Biologists between 2007and 2009 and four species were found: *Pacifasticus gambelii, Orconectes immunis, O. virilis, and O. neglectus neglectus. Pacifasticus gambelii* was the only species found in the Snake River drainage. *Orconectes virilis* was the only species found in the Bear River drainage and appeared to have displaced *P. gambelii* which was the only species found in the drainage during a 1985-1987 crayfish survey. *Orconectes immunis* and *O. virilis* were widespread throughout the Missouri and Green River drainages, and there was evidence of displacement of *O. immunis* by *O. virilis* at several locations since a 1985-1987 crayfish survey. *Orconectes neglectus neglectus* was found only in the reservoirs in the Crow Creek drainage within the South Platte River drainage. Observed differences in occurrences of crayfishes between 1985-1987 and 2007-2009 indicated that *O. virilis* should be identified as an invasive species that displaces other crayfishes in Wyoming.

Among the 363 crayfishes native to the United States and Canada, 2 taxa (< 1%) were listed as Endangered, Possibly Extinct, 66 taxa (18.2%) were Endangered, 52 taxa (14.3%) were Threatened, 54 taxa (14.9%) were Vulnerable, and 189 taxa (52.1%) were considered Currently Stable in an assessment conducted by Taylor et al. (2007). They concluded that limited natural range was the primary factor responsible for the noted imperilment of crayfishes, but other threats included the introduction of nonindigenous crayfishes and habitat alterations. The threat of nonindigenous species has increased largely due to unintended introductions and the presence of conduits facilitating the dispersal of nonindigenous species. Subsequent displacement of

native species by nonnative species has become a common occurrence among crayfishes (Bovbjerg 1970; Lodge et al. 1985; Clark and Lester 2005).

Between 1985 and 1987 a survey of crayfishes was conducted in Wyoming (Hubert 1988). During that survey five species of crayfishes were found in Wyoming: *Pacifasticus gambelii, Orconectes immunis, O. virilis, O. neglectus,* and *Cambarus diogenes. Pacifasticus gambelii,* a species native to the Snake and Bear River drainages, was the only species found in those two drainages. *Orconectes immunis* and *O. virilis* were widespread throughout the Missouri River drainage where they are native, but they were also found in the Green River drainage where they have been introduced. *Orconectes neglectus neglectus*, a species native to the Missouri River drainage, was found in a single reservoir in the South Platte River drainage. *Cambarus diogenes diogenes*, a species that is widespread east of the Rocky Mountains, was found in a tributary to the North Platte River in eastern Wyoming.

A survey was conducted between 2007 and 2009 to obtain a more thorough understanding of the crayfishes present in Wyoming and identify changes that may have occurred since the 1985-1987 survey. Fisheries biologists with the Wyoming Game and Fish Department (WGFD) collected crayfish from throughout the state. They targeted locations were the occurrence of nonindigenous crayfish was expected based on recent findings of unauthorized introductions of nonindigenous crayfishes and fishes, and histories of stocking of fishes by private landowners. They also targeted locations that had been sampled during the 1985-1987 survey of crayfishes in Wyoming.

Methods

Biologists sampled crayfish with traps, seines, or dip nets, or collected them from gillnets and trammel nets used to sample fishes. They were asked to collect and preserve 15-20 sexually mature "first form" males from each sampling site because the morphology of the male sexual appendages is used in species identification. The crayfish were placed in wide-mouth jars and preserved in 80-90% ethanol. The biologists were asked to prepare two labels for each jar, one was inserted in the jar and another was fastened to the exterior of the jar. Each label was to include: the name of the water body, a description of the sampling site relative to nearby landmarks, a description of the habitat, Universal Transverse Mercator (UTM) coordinates for the site, notation of the owner with contact information if on private land, date of collection, sampling method, and number of specimens in the jar. Collections were transferred to the U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit at the University of Wyoming for identification and returned to the WGFD following identification. Identifications followed Hobbs (1972) and (1985).

Results and Discussion

Samples were obtained from 84 sites throughout Wyoming. First-form males were present in samples from 69 sites enabling identification to the species level. Samples with only females or immature males were identified to genera. Four species of crayfish were identified among the 66 samples with first-form males: *Pacifasticus gambelii*, *Orconectes virilis*, *O. immunis*, and *O. neglectus neglectus* (Table 1). Twelve sites were sampled during both the 1985-1987 and 2007-2009 surveys of crayfishes in Wyoming (Table 2).

The only species collected in the Snake River drainage during both the 1985-1987 and 2007-2009 surveys was *P. gambelii* where the species is endemic (Tables 1 and 2). There was no evidence of the presence of nonindigenous crayfishes in the Snake River drainage.

Within the Bear River drainage, the only species found during the 2007-2009 survey was *O. virilis* (Table 1). Samples from the Bear River drainage during the 1985-1987 crayfish survey yielded only *P. gambelii* (Table 2), the only species believed to be endemic to the watershed. Introduction of *O. virilis* with widespread invasion and displacement of the native *P. gambelii* appears to have occurred in the Bear River drainage since the 1985-1987 survey. Localized extinctions of native crayfishes, including *P. gambelii*, by invasive *O. virilis* has been observed in Idaho (Clark and Lester 2005).

Orconectes virilis and *O. immunis* were the only species collected in the Green River, North Platte River, and Big Horn River drainages during the 2007-2009 survey (Table 1). Within those three drainages, there were two sampled locations (i.e., Seminoe Reservoir and the North Platte River in Carbon County) where *O. immunis* was the only species sampled during the 1985-1987 survey, but *O. virilis* was also present in samples from 2007-2009 (Table 2). Further, there were three locations in these drainages where both *O. immunis* and *O. virilis* were collected during 1985-1987 (i.e., Alcova Reservoir, Boysen Reservoir, and Maverick Pond), but only *O. virilis* was found during 2007-2009 (Table 2). Similarly, both species were found in Sloans Lake in the South Platte River drainage during the 1985-1987 survey, but only *O. virilis* was collected during the 2007-2009 survey (Table 2). Competitive exclusion of *O. immunis* by *O. virilis* was described by Bovbjerg (1970). This process appears to be going on in reservoirs and small impoundments in Wyoming.

Orconectes neglectus neglectus was found in one location, Crystal Reservoir, in the South Platte River drainage during the 1985-1987 survey (Table 2). During the 2007-2009 survey, this species was found in both Crystal and Granite reservoirs (Table 1). The only other species found in the South Platte River drainage during the 1985-1987 survey was *O. immunis* (Hubert 1988), but during the 2007-2009 survey, *O. virilis* was found at two locations in the watershed (Table 1).

During the 1985-1987 survey, *C. diogenes diogenes* was collected from Horse Creek, a tributary to the North Platte River in Goshen County (Hubert 1988). Horse Creek was not sampled during the 2007-2009 survey, and this species was not found at any of the locations sampled during the 2007-2009 survey.

All samples were carefully examined for the presence of *O. rusticus* and none were found. There was no evidence that *Orconectes rusticus* has become established in Wyoming, but samples were not obtained from Wagonhound Creek, downstream in the Medicine Bow River, or Medicine Bow Arm of Seminoe Reservoir.

Management Implications and Research Needs

Because the introduction of exotic crayfish species can lead to displacement of native crayfishes, and there is evidence of this occurring in Wyoming, the transplanting or transporting of crayfish among waters should be discouraged through regulations and public education. *Orconectes virilis* appears to be a particularly invasive species that not only disperses and out competes native crayfishes, but may also adversely affect fishes in reservoirs (Hepworth and Duffield 1987) and consume aquatic macrophytes (Dean 1969; Johnson 1976). Similarly, *Orconectes rusticus* poses such threats when introduced outside of its native range (Capelli 1982; Lodge and Lorman 1987; Hill and Lodge 1999).

There is no information on the ecosystem-scale effects of invasive crayfishes on streams, natural lakes, or reservoirs in Wyoming. It is likely that the replacement of native crayfishes by introduced invasive crayfishes may have substantial effects on systems and influence their fish production potentials. Research into this topic is warranted from the perspectives of both fisheries management and conservation biology.

Because of the threats that invasive crayfishes pose to native crayfishes and aquatic systems, research regarding methods to control introduced populations may be warranted. Research on this topic is being conducted by Scott Bonar with the Arizona Cooperative Fish and Wildlife Research Unit and may serve as a nucleus for research efforts in Wyoming.

Acknowledgments

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Table 1. Crayfish collection sites and species in the genera *Orconectes* and *Pacifasticus* identified from samples collected 2007-2009 in Wyoming.

Drainage	Site name or description	Universal Transverse Mercator coordinates	Species
Snake River	Thomas Fork at Dipper Creek confluence	12T 501218E 4695952N	*P. gambelii*
	Giraffe Creek below Salt Basin confluence	12T 499216E 4697889N	*P. gambelii*
	Teton Valley Ranch spring near Gros Ventre River	12T 531750E 4830100N	*P. gambelii*
Bear River	Bear River, Bear River State Park	12T 505744E 4567253N	*O.* sp.
	Bear River, Bear River State Park	12T 505832E 4567132N	*O. virilis*
	Woodruff Reservoir	12T 498402E 4594405N	*O. virilis*
	Bear River, below Woodruff Reservoir	12T 498937E 4594660N	*O.* sp.
	Sulphur Creek Reservoir	12T 516002E 4555609N	*O. virilis*
	Smith Fork River, in mountains just east of Highway 414	12T 505832E 4568959N	*O.* sp.
Green River	Meadow Lake	12T 607376E 4749143N	*O. virilis*
	Fontenelle Reservoir	12T 562112E 4650048N	*O. immunis*
	Big Sandy River	12T 618951E 4651819N	*O. immunis* *O. virilis*
	Green River, OCI Wyoming	12T 607663E 4617773N	*O. virilis*
	Hamms Fork River, 4.6 mi. north of Opal, WY	12T 563548E 4625641N	*O. virilis*
	Blacks Fork River at I-80	12T 609025E 4599531N	*O. virilis*
	Blacks Fork River, downstream from Hamms Fork	12T 589273E 4606630N	*O. virilis*
	Flaming Gorge Reservoir	12T 613441E 4540343N	*O. virilis*
	Flaming Gorge Reservoir at confluence	12T 622713E 4572012N	*O. virilis*
	Flaming Gorge Reservoir, Buckboard Bay	12T 618407E 4566979N	*O. virilis*
	Flaming Gorge Reservoir, Haystack Butte	12T 619762E 4555151N	*O. virilis*
	Jim Bridger Pond	12T 684315E 4621962N	*O. virilis*

Table 1. Continued.

Drainage	Site name or description	Universal Transverse Mercator coordinates	Species
Little Snake River	Little Snake River in Baggs, WY	13T 276581E 4546333N	*O. virilis*
	Harold's Slough, pond in irrigation ditch, Baggs, WY	12T 276143E 4545559N	*O. virilis*
	Muddy Creek at confluence with Little Snake River	13T 277225E 4546422N	*O. virilis*
	Muddy Creek, 12 mi. north of Baggs, WY	13T 274857E 4564915N	*O. virilis*
	Little Muddy Creek at Red Wash	13T 268426E 4577300N	*O. virilis*
	Little Robbers Gulch Reservoir	13T 272157E 4563199N	*O. virilis*
	Savery Creek at Highway 70	13T 294452E 4544205N	*O. virilis*
North Platte River	North Platte River, upstream of Treasure Island	13T 356698E 4574525N	*O.* sp.
	North Platte River, 2 mi. upstream from I-80		*O. immunis*
	North Platte River, Dugway BLM Campground	13T 329411E 4636365N	*O. virilis*
	North Platte River, Miracle Mile	13T 345250E 4674302N	*O.* sp.
	Seminoe Reservoir	13T 347090E 4662860N	*O. immunis*
			O. virilis
	Sage Creek, near Sage Creek Road	13T 343977E 4678924N	*O. virilis*
	East Allen Reservoir	13T 398598E 4636012N	*O. immunis*
	Pathfinder Reservoir	13T 344457E 4696634N	*O. virilis*
	Alcova Reservoir	13T 356335E 4710081N	*O. virilis*
	Fish Creek	13T 342788E 4719575N	*O. virilis*
	North Platte River, Bixby Public Access Area	13T 445271E 4744968N	*O. virilis*
	Poison Spider Creek at Poison Spider Road	13T 362776E 4742499N	*O. immunis*
	North Platte River, Dave Johnson Public Access Area	13T 434136E 4743374N	*O. immunis*
	Deer Creek	13T 428074E 4742813N	*O. virilis*
	Horseshoe Creek	13T 472980E 4692380N	*O. virilis*
	Cottonwood Creek, near confluence with North Cottonwood Creek	13T 470687E 4680378N	*O. immunis*

Table 1. Continued.

Drainage	Site name or description	Universal Transverse Mercator coordinates	Species
	Negro Baby Creek	13T 541035E 4708615N	*O. immunis*
	Glendo Reservoir, near dam	13T 503772E 4702466N	*O. immunis*
			O. virilis
	Lake Hattie	13T 422714E 4565094N	*O. immunis*
	Laramie River at Laramie Green Belt	13T 449239E 4573745N	*O. virilis*
	Laramie River	13T 465694E 4641578N	*O. virilis*
	North Platte River, below Whalen Diversion Dam	13T 532185E 4675426N	*O. virilis*
	North Platte River, near Torrington, WY	13T 559638E 4659709N	*O. virilis*
	Packers Lake	13T 578536E 4638557N	*O. virilis*
	North Platte River, near NB state line	13T 572418E 4653655N	*O.* sp.
South Platte River	Crystal Reservoir	13T 483262E 4555682N	*O. neglectus*
			O. immunis
	Granite Reservoir	13T 480475E 4558418N	*O. neglectus*
	South Fork Middle Crow Creek, on national forest	13T 481526E 4557085N	*O.* sp.
	Sloans Lake	13T 514356E 4556199N	*O. virilis*
	Crow Creek at Hereford Ranch	13T 523947E 4551775N	*O. immunis*
	Imson Lake, on Pete Creek near Texas Creek	13T 468986E 4546902N	*O. virilis*
Cheyenne River	LAK Reservoir, True Ranch, near Newcastle, WY	13T 571827E 4852502N	*O.* sp.
Belle Fourche River	Belle Fourche River, State Section R69T49S36	13T 492920E 4891795N	*O. immunis*
	Belle Fourche River, near Colony, WY	13T 563032E 4963287N	*O.* sp.
	Beaver Creek, U.S. Forest Service land	13T 548855E 4943372N	*O.* sp.
	Beaver Creek, state land on lower creek	13T 565140E 4828228N	*O. immunis*
	Iron Creek, county road crossing	13T 541380E 4876380N	*O.* sp.

Table 1. Continued.

Drainage	Site name or description	Universal Transverse Mercator coordinates	Species
	Turner Creek, 300 ft. downstream from Turner Reservoir	13T 546511E 4875823N	*O.* sp.
	Sundance Fairgrounds Pond	13T 550353E 4916993N	*O.* sp.
	Inyan Kara Creek, state land near confluence with with Belle Fourche River	13T 521927E 4920786N	*O. immunis*
	Inyan Kara Creek	13T 544122E 4897428N	*O.* sp.
Powder River	Clear Creek at Gordon Diversions	13T 372833E 4919631N	*O. immunis*
	Muddy Guard 1 Reservoir	13T 358022E 4892988N	*O. immunis*
	Muddy Guard 2 Reservoir	13T 359682E 4893368N	*O. immunis*
Tongue River	Big Goose Creek, Kendrick Park, Sheridan, WY	13T 358022E 4892988N	*O.* sp.
Big Horn River	Markham Reservoir, Cody, WY	12T 655209E 4930184N	*O. immunis*
	Deaver Reservoir, Deaver, WY	12T 686447E 4874371N	*O. immunis*
	Buffalo Bill Reservoir, Cody, WY	12T 642481E 4922326N	*O. virilis*
	Ocean Lake	12T 694361E 4782915N	*O. virilis*
	Big Bend Pond #5	12T 714673E 4765260N	*O. virilis*
	Maverick Pond, Lander, WY	12T 686329E 4746041N	*O. virilis*
	Boysen Reservoir		*O. virilis*
	Big Horn Reservoir	12T 716988E 4986344N	*O. virilis*
	Wardell Reservoir	12T 714723E 4914012N	*O. virilis*
	Spring ponds on Bob Bauman property, West Fork Dry Creek, tributary to Badwater Creek, flows into Boysen Reservoir	13T 259905E 4809222N	*O. virilis*
Clark's Fork of the Yellowstone River	Lily Lake, Beartooth Mountains, Park County	12T 601585E 4977481N	*O. immunis*

Table 2. Crayfish species of the genera *Orconectes* and *Pacifasticus* captures at sites sampled during both 1985-1987 and 2007-2009 in Wyoming.

Drainage	Site	Survey	
		1985-1987	2007-2009
Snake River	Teton Valley Ranch spring	*P. gambelii*	*P. gambelii*
Bear River	Woodruff Reservoir	*P. gambelii*	*O. virilis*
	Bear River	*P. gambelii*	*O. virilis*
North Platte River	Lake Hattie	*O. immunis*	*O. immunis*
	Seminoe Reservoir	*O. immunis*	*O. immunis*
			O. virilis
	North Platte River, Carbon County	*O. immunis*	*O. immunis*
			O. virilis
	Alcova Reservoir	*O. immunis*	*O. virilis*
		O. virilis	
South Platte River	Sloans Lake	*O. immunis*	*O. virilis*
		O. virilis	
	Crystal Reservoir	*O. neglectus*	*O. neglectus*
			O. immunis
Big Horn River	Boysen Reservoir	*O. immunis*	*O. virilis*
	Maverick Pond	*O. immunis*	*O. virilis*
Clarks Fork of the Yellowstone River	Lily Lake	*O. immunis*	*O. immunis*